

Docket No. 247627US-2SRD DIV
Inventor: Yoshiaki SAITO, et al.

LISTING OF CLAIMS

Claims 1-21 (Canceled)

Claim 22 (New): A magnetic memory comprising:

first and second wirings intersecting each other and positioned apart from each other;

a magnetoresistance effect film positioned between the first and second wirings and comprising,

a magnetic recording layer configured to reverse a magnetization direction thereof by passing writing currents through the first and second wirings,

a first magnetization pinned layer positioned between the first wiring and the magnetic recording layer and configured to hold magnetization direction thereof when passing the writing currents through the first and second wirings, and

a first nonmagnetic layer intervening between the magnetic recording layer and the first magnetization pinned layer; and

a first magnetic film covering a back surface and side surfaces of the first wiring, the back surface being opposite to a front surface of the first wiring that faces the magnetoresistance effect film, wherein each portion of the first magnetic film that covers the side surface of the first wiring extends across a plane including the front surface with an insulating film interposed between the magnetic recording layer and the portion of the first magnetic film covering the side surface of the first wiring.

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Claim 23 (New): The memory according to Claim 22, wherein the first magnetic film further covers side surfaces of the first magnetization pinned layer with the insulating film interposed therebetween.

Claim 24 (New): The memory according to Claim 22, wherein the first magnetic film further covers side surfaces of the magnetic recording layer with the insulating film interposed therebetween.

Claim 25 (New): The memory according to Claim 22, wherein the magnetoresistance effect film further comprises,

a second magnetization pinned layer configured to hold a magnetization direction thereof when passing the writing currents through the first and second wirings, the first and second magnetization pinned layers sandwiching the magnetic recording layer and the first nonmagnetic layer, and
a second nonmagnetic layer intervening between the magnetic recording layer and the second magnetization pinned layer.

Claim 26 (New): The memory according to Claim 22, further comprising a second magnetic film covering a back surface and side surfaces of the second wiring, the back surface of the second wiring being opposite to a front surface of the second

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wiring that faces the magnetoresistance effect film.

Claim 27 (New): The memory according to Claim 22, wherein a length of the first magnetic film along a longitudinal direction of the first wiring is 1.2 times or more a length of the magnetoresistance effect film along the longitudinal direction of the first wiring.

Claim 28 (New): The memory according to Claim 22, wherein the first magnetic film comprises either a high saturation magnetization soft magnetic material containing cobalt or a metal-nonmetal nano-granular film.

Claim 29 (New): The memory according to Claim 28, wherein the first magnetic film comprises a high permeable magnetic material as the high saturation magnetization soft magnetic material, the high permeable magnetic material is an alloy containing cobalt or cobalt-iron as a main component, and the first and second wirings contain one material selected from the group consisting of copper, tungsten, and an alloy of copper and tungsten.

Claim 30 (New): The memory according to Claim 28, wherein the first magnetic film comprises a high permeable magnetic material as the high saturation magnetization soft magnetic material, the high permeable magnetic material is an alloy containing cobalt or cobalt-iron as a main component, and each of the first and

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second wirings has a multilayered structure including a nonmagnetic layer and a high saturation magnetization soft magnetic material layer.

Claim 31 (New): The memory according to Claim 28, wherein the first magnetic film comprises at least one film selected from the group consisting of a Co-Fe alloy film, a Co-Fe-Ni alloy film, a Co-(Zr, Hf, Nb, Ta, Ti) film, an amorphous film of these films, and a metal-nonmetal nano-granular film.

Claim 32 (New): The memory according to Claim 22, wherein the nonmagnetic layer is a nonmagnetic tunnel layer.

Claim 33 (New): The memory according to Claim 22, further comprising a sense current control element configured to control a sense current to be passed through the magnetic memory.

Claim 34 (New): A magnetic memory comprising:
first and second wirings intersecting each other and positioned apart from each other;
a magnetoresistance effect film positioned between the first and second wirings and comprising,
a magnetic recording layer configured to reverse a magnetization direction thereof by passing writing currents through the first and second wirings,

a first magnetization pinned layer positioned between the first wiring and the magnetic recording layer and configured to hold a magnetization direction thereof when passing the writing currents through the first and second wirings, the first magnetization pinned layer being narrower in a width direction of the first wiring than the magnetic recording layer, and

a first non-magnetic layer intervening between the magnetic recording layer and the first magnetization pinned layer, the first nonmagnetic layer being wider in the width direction than the first magnetization pinned layer; and

a first magnetic film covering a back surface and side surfaces of the first wiring, the back surface being opposite to a front surface of the first wiring that faces the magnetoresistance effect film, wherein the magnetic recording layer is wider in the width direction than the first wiring, and each portion of the first magnetic film that covers the side surface of the first wiring is in contact with a surface of the first nonmagnetic layer on the side of the first magnetization pinned layer.

Claim 35 (New): The memory according to Claim 34, wherein the magnetoresistance effect film further comprises,

a second magnetization pinned layer configured to hold a magnetization direction thereof when passing the writing currents through the first and second wirings, the first and second magnetization pinned layers sandwiching the magnetic recording layer and the first nonmagnetic layer, and

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a second nonmagnetic layer intervening between the magnetic recording layer and the second magnetization pinned layer.

Claim 36 (New): The memory according to Claim 34, further comprising a second magnetic film covering a back surface and side surfaces of the second wiring, the back surface of the second wiring being opposite to a front surface of the second wiring that faces the magnetoresistance effect film.

Claim 37 (New): The memory according to Claim 34, wherein a length of the first magnetic film along a longitudinal direction of the first wiring is 1.2 times or more a length of the magnetoresistance effect film along the longitudinal direction of the first wiring.

Claim 38 (New): The memory according to Claim 34, wherein the first magnetic film comprises a high saturation magnetization soft magnetic material containing cobalt or a metal-nonmetal nano-granular film.

Claim 39 (New): The memory according to Claim 38, wherein the first magnetic film comprises a high permeable magnetic material as the high saturation magnetization soft magnetic material, the high permeable magnetic material is an alloy containing cobalt or cobalt-iron as a main component, and the first and second wirings contain one material selected from the group consisting of copper, tungsten,

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and an alloy of copper and tungsten.

Claim 40 (New): The memory according to Claim 38, wherein the first magnetic film comprises a high permeable magnetic material as the high saturation magnetization soft magnetic material, the high permeable magnetic material is an alloy containing cobalt or cobalt-iron as a main component, and each of the first and second wirings has a multilayered structure including a nonmagnetic layer and a high saturation magnetization soft magnetic material layer.

Claim 41 (New): The memory according to Claim 38, wherein the first magnetic film comprises at least one film selected from the group consisting of a Co-Fe alloy film, a Co-Fe-Ni alloy film, a Co-(Zr, Hf, Nb, Ta, Ti) film, an amorphous film of these films, and a metal-nonmetal nano-granular film.

Claim 42 (New): The memory according to Claim 34, wherein the nonmagnetic layer is a nonmagnetic tunnel layer.

Claim 43 (New): The memory according to Claim 34, further comprising a sense current control element configured to control a sense current to be passed through the magnetic memory.

Claim 44 (New): A magnetic memory comprising:

first and second wirings intersecting each other and positioned apart from each other;

a magnetoresistance effect film positioned between the first and second wirings and comprising,

a magnetic recording layer configured to reverse a magnetization direction thereof by passing writing currents through the first and second wirings, between a first direction and a second direction different from the first direction,

a first magnetization pinned layer positioned between the first wiring and the magnetic recording layer and configured to hold a magnetization direction thereof when passing the writing currents through the first and second wirings, the first magnetization pinned layer being narrower in a width direction of the first wiring than the magnetic recording layer, and

a first nonmagnetic layer intervening between the magnetic recording layer and the first magnetization pinned layer; and

a first magnetic film covering a back surface and side surfaces of the first wiring, the back surface being opposite to a front surface of the first wiring that faces the magnetoresistance effect film, wherein the magnetic recording layer is wider in the width direction than the first wiring, an oxide layer is formed on a portion of a surface of the magnetic recording layer that faces the front surface, the portion is not covered with the first magnetization pinned layer, and each portion of the first magnetic film that covers the side surface of the first wiring is in contact with the magnetic recording layer via the oxide layer.

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Claim 45 (New): The memory according to Claim 44, wherein the magnetoresistance effect film further comprises,

a second magnetization pinned layer configured to hold a magnetization direction thereof when passing the writing currents through the first and second wirings, the first and second magnetization pinned layers sandwiching the magnetic recording layer and the first nonmagnetic layer, and

a second nonmagnetic layer intervening between the magnetic recording layer and the second magnetization pinned layer.

Claim 46 (New): The memory according to Claim 44, further comprising a second magnetic film covering a back surface and side surfaces of the second wiring, the back surface of the second wiring being opposite to a front surface of the second wiring that faces the magnetoresistance effect film.

Claim 47 (New): The memory according to Claim 44, wherein a length of the first magnetic film along a longitudinal direction of the first wiring is 1.2 times or more a length of the magnetoresistance effect film along the longitudinal direction of the first wiring.

Claim 48 (New): The memory according to Claim 44, wherein the first magnetic film comprises a high saturation magnetization soft magnetic material

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containing cobalt or a metal-nonmetal nano-granular film.

Claim 49 (New): The memory according to Claim 48, wherein the first magnetic film comprises a high permeable magnetic material as the high saturation magnetization soft magnetic material, the high permeable magnetic material is an alloy containing cobalt or cobalt-iron as a main component, and the first and second wirings contain one material selected from the group consisting of copper, tungsten, and an alloy of copper and tungsten.

Claim 50 (New): The memory according to Claim 48, wherein the first magnetic film comprises a high permeable magnetic material as the high saturation magnetization soft magnetic material, the high permeable magnetic material is an alloy containing cobalt or cobalt-iron as a main component, and each of the first and second wirings has a multilayered structure including a nonmagnetic layer and a high saturation magnetization soft magnetic material layer.

Claim 51 (New): The memory according to Claim 48, wherein the first magnetic film comprises at least one film selected from the group consisting of a Co-Fe alloy film, a Co-Fe-Ni alloy film, a Co-(Zr, Hf, Nb, Ta, Ti) film, an amorphous film of these films, and a metal-nonmetal nano-granular film.

Claim 52 (New): The memory according to Claim 44, wherein the

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nonmagnetic layer is a nonmagnetic tunnel layer.

Claim 53 (New): The memory according to Claim 44, further comprising a sense current control element configured to control a sense current to be passed through the magnetic memory.

Claim 54 (New): A magnetic memory comprising:

first and second wirings intersecting each other and positioned apart from each other;

a magnetoresistance effect film positioned between the first and second wirings and comprising,

a magnetic recording layer configured to reverse a magnetization direction thereof by passing writing currents through the first and second wirings,

a first magnetization pinned layer facing the magnetic recording layer and configured to hold a magnetization direction thereof when passing the writing currents through the first and second wirings, and

a first nonmagnetic layer intervening between the magnetic recording layer and the first magnetization pinned layer; and

a first magnetic film covering a back surface and side surfaces of the first wiring, the back surface being opposite to a front surface of the first wiring that faces the magnetoresistance effect film, wherein each portion of the first magnetic film that covers the side surface of the first wiring extends across a plane including the front

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surface with an insulating film interposed between the magnetic recording layer and the portion of the first magnetic film covering the side surface of the first wiring.

Claim 55 (New): The memory according to Claim 54, wherein the first magnetic film further covers side surfaces of the first magnetization pinned layer with the insulating film interposed therebetween.

Claim 56 (New): The memory according to Claim 54, wherein the first magnetic film further covers side surfaces of the magnetic recording layer with the insulating film interposed therebetween.

Claim 57 (New): The memory according to Claim 54, wherein the magnetoresistance effect film further comprises,

a second magnetization pinned layer configured to hold a magnetization direction thereof when passing the writing currents through the first and second wirings, the first and second magnetization pinned layers sandwiching the magnetic recording layer and the first nonmagnetic layer, and

a second nonmagnetic layer intervening between the magnetic recording layer and the second magnetization pinned layer.

Claim 58 (New): The memory according to Claim 54, further comprising a second magnetic film covering a back surface and side surfaces of the second wiring,

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the back surface of the second wiring being opposite to a front surface of the second wiring that faces the magnetoresistance effect film.

Claim 59 (New): The memory according to Claim 54, wherein a length of the first magnetic film along a longitudinal direction of the first wiring is 1.2 times or more a length of the magnetoresistance effect film along the longitudinal direction of the first wiring.

Claim 60 (New): The memory according to Claim 54, wherein the first magnetic film comprises either a high saturation magnetization soft magnetic material containing cobalt or a metal-nonmetal nano-granular film.

Claim 61 (New): The memory according to Claim 60, wherein the first magnetic film comprises a high permeable magnetic material as the high saturation magnetization soft magnetic material, the high permeable magnetic material is an alloy containing cobalt or cobalt-iron as a main component, and the first and second wirings contain one material selected from the group consisting of copper, tungsten, and an alloy of copper and tungsten.

Claim 62 (New): The memory according to Claim 60, wherein the first magnetic film comprises a high permeable magnetic material as the high saturation magnetization soft magnetic material, the high permeable magnetic material is an

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alloy containing cobalt or cobalt-iron as a main component, and each of the first and second wirings has a multilayered structure including a nonmagnetic layer and a high saturation magnetization soft magnetic material layer.

Claim 63 (New): The memory according to Claim 60, wherein the first magnetic film comprises at least one film selected from the group consisting of a Co-Fe alloy film, a Co-Fe-Ni alloy film, a Co- (Zr, Hf, Nb, Ta, Ti) film, an amorphous film of these films, and a metal-nonmetal nano-granular film.

Claim 64 (New): The memory according to Claim 54, wherein the nonmagnetic layer is a nonmagnetic tunnel layer.

Claim 65 (New): The memory according to Claim 54, further comprising a sense current control element configured to control a sense current to be passed through the magnetic memory.